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Seeding Southern Idaho Rangelands

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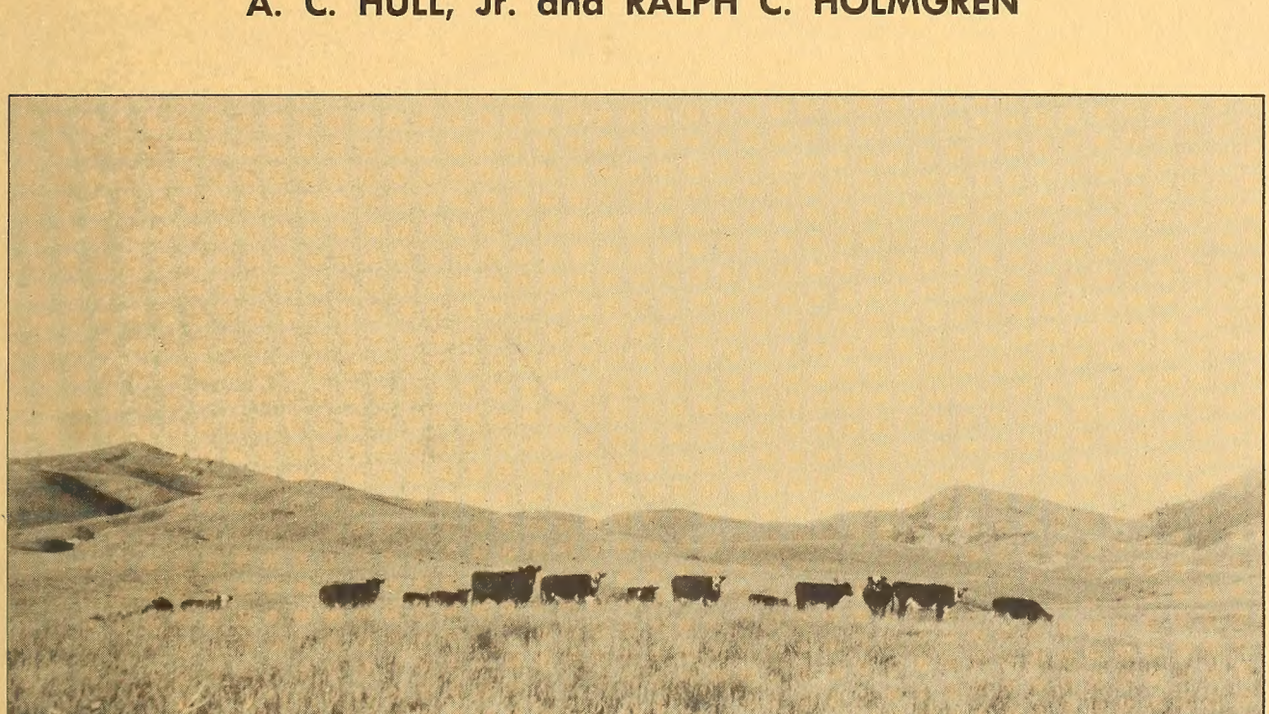
A. C. HULL, Jr. and RALPH C. HOLMGREN



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Forest Service
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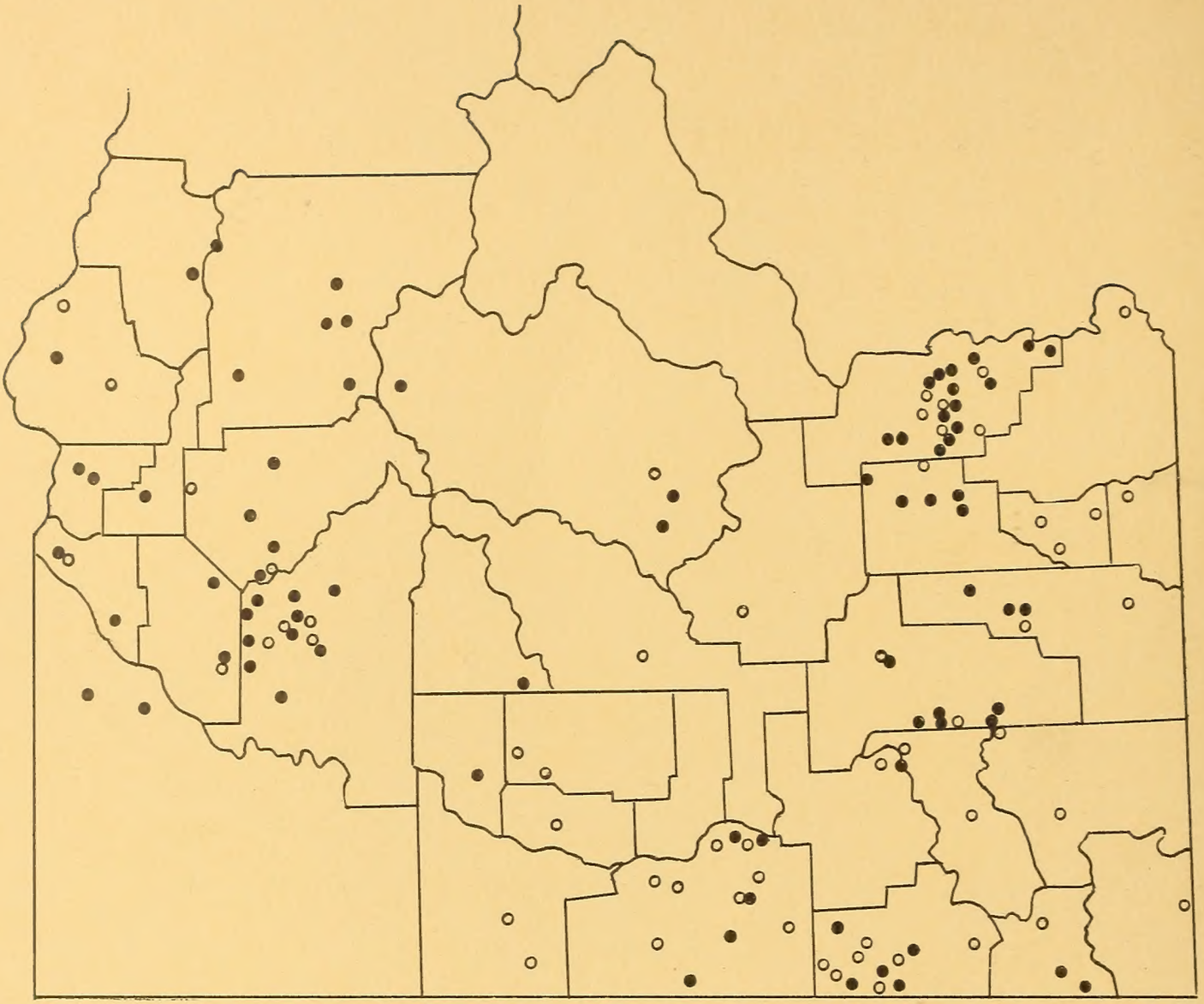

Sites of experimental (•) and large-scale (o) seedings in southern Idaho on which this paper is based.

COVER PHOTO

Cattle on seeded crested wheatgrass range near Willow Creek, Boise National Forest, Elmore County, Idaho

U.S. Forest Service
Research Paper INT-10
1964

SEEDING SOUTHERN IDAHO RANGELANDS

by

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PREFACE

This publication summarizes available information and experience to serve as a guide to range seeding. Recommendations are based primarily on results of experimental seedings made since 1936 in southern Idaho. More than 230 species have been planted in more than 13,000 plots at 79 locations. Many large-scale seedings have been observed to check the soundness of recommendations for species, methods, and management practices. Locations of the experimental and large-scale seedings are shown on the map inside the front cover. Results of some of the research have been published previously. This publication reviews published information and presents additional information previously unpublished.

The studies were planned to determine adapted species and to develop effective methods of seeding southern Idaho rangelands. Many of the seedings were grazed. They show the relative palatability and grazing tolerance of individual species. The studies and large seedings have shown that seeding can be a profitable investment.

Much of the work reported here was cooperative with ranchers. Cooperating agencies included the Agricultural Research Service, Soil Conservation Service, and Forest Service, U.S. Department of Agriculture; the Bureau of Indian Affairs, and Bureau of Land Management, U.S. Department of the Interior; and the University of Idaho.

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SEEDING SOUTHERN IDAHO RANGELANDS

INTRODUCTION

Seeding is the key to quick restoration of an estimated 6 million acres of deteriorated southern Idaho rangeland. Seeding can increase forage and produce more feed for livestock and game animals than would be available naturally. Also, increased herbage usually helps protect the soil from forces that cause erosion, and it promotes more effective infiltration of moisture into the ground. Seeding depleted lands also indirectly benefits adjacent ranges since use of the additional forage obtained by seeding can lighten grazing pressure on these areas and facilitate their natural improvement.

Some seeded species are suitable for grazing earlier in the season than are the plants now occupying lands that need seeding (figs. 1 and 2). Grazing can be extended later into the season by seeding late-maturing species. Yearly production by perennial species that are adapted to a site varies less than that of annuals. Hence, perennials furnish a more dependable source of forage than annuals (Stewart and Hull 1949)[1] (fig. 3) and this forage has better quality. This is especially true where the annuals are undesirable or poisonous species such as medusahead[2] and halogeton (fig. 4). Seeding key areas with grass will replace annual weeds that are hosts of the beet leafhopper and will thus reduce losses of beets, beans, and tomatoes caused by the curly-top virus (Piemeisel and Chamberlin 1936).

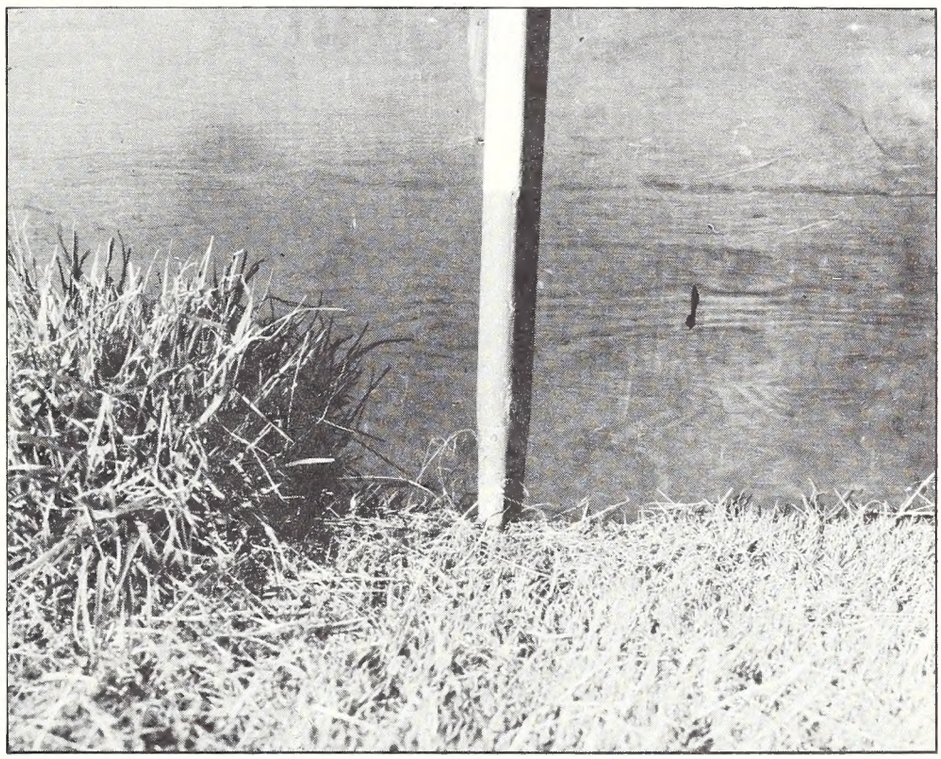

Figure 1. -- Fairway wheatgrass plant at left had green leaves 8 inches long in mid-March 1957. Cheatgrass at right and in foreground is only 1½ inches tall. Elmore County.

[1] See References, pp. 27-28.

[2] A list of common and scientific names of all species mentioned appears on pp. 25-26.

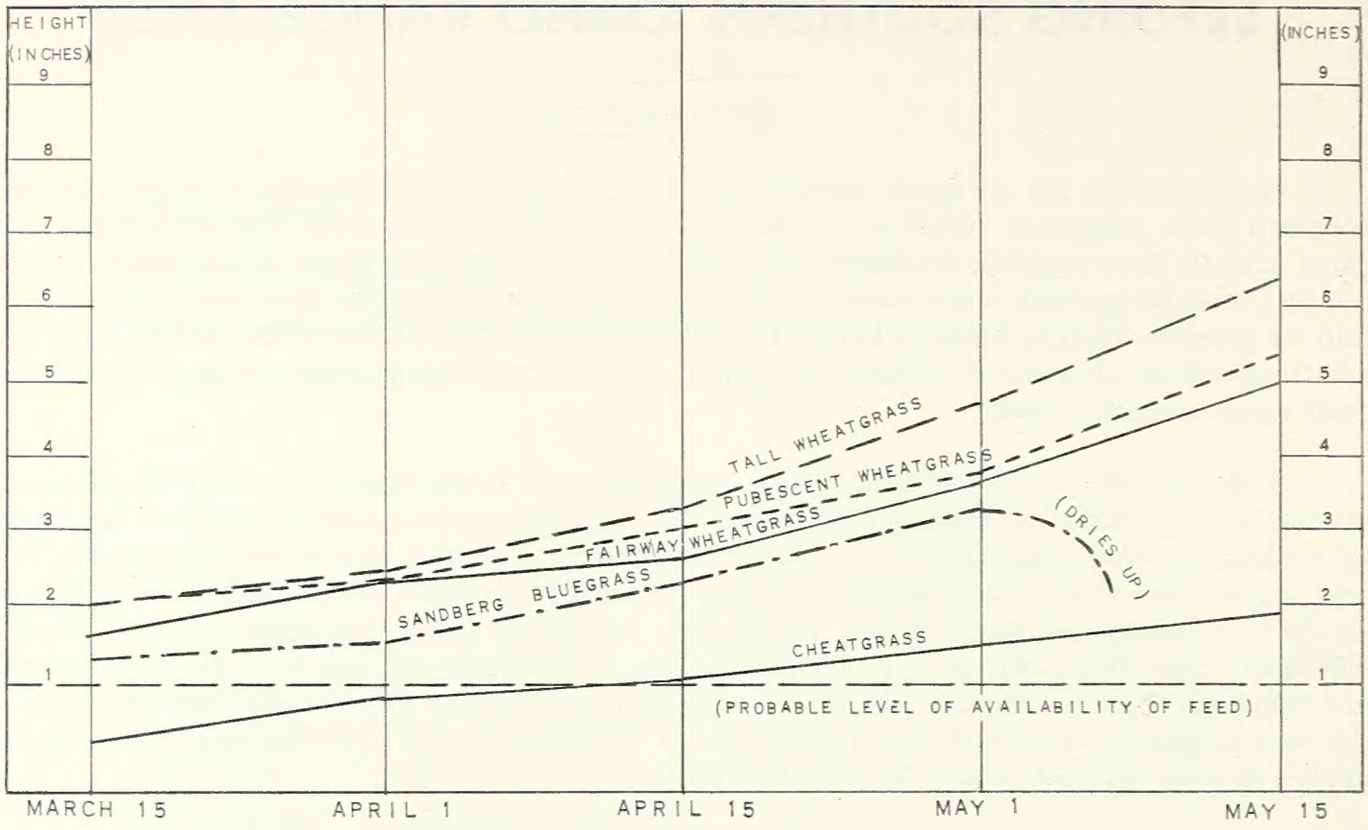

Figure 2.--Heights of plants of five grass species at five dates. Heights shown are averages of measurements in 1947, 1948, 1949, and 1950. Elmore County.

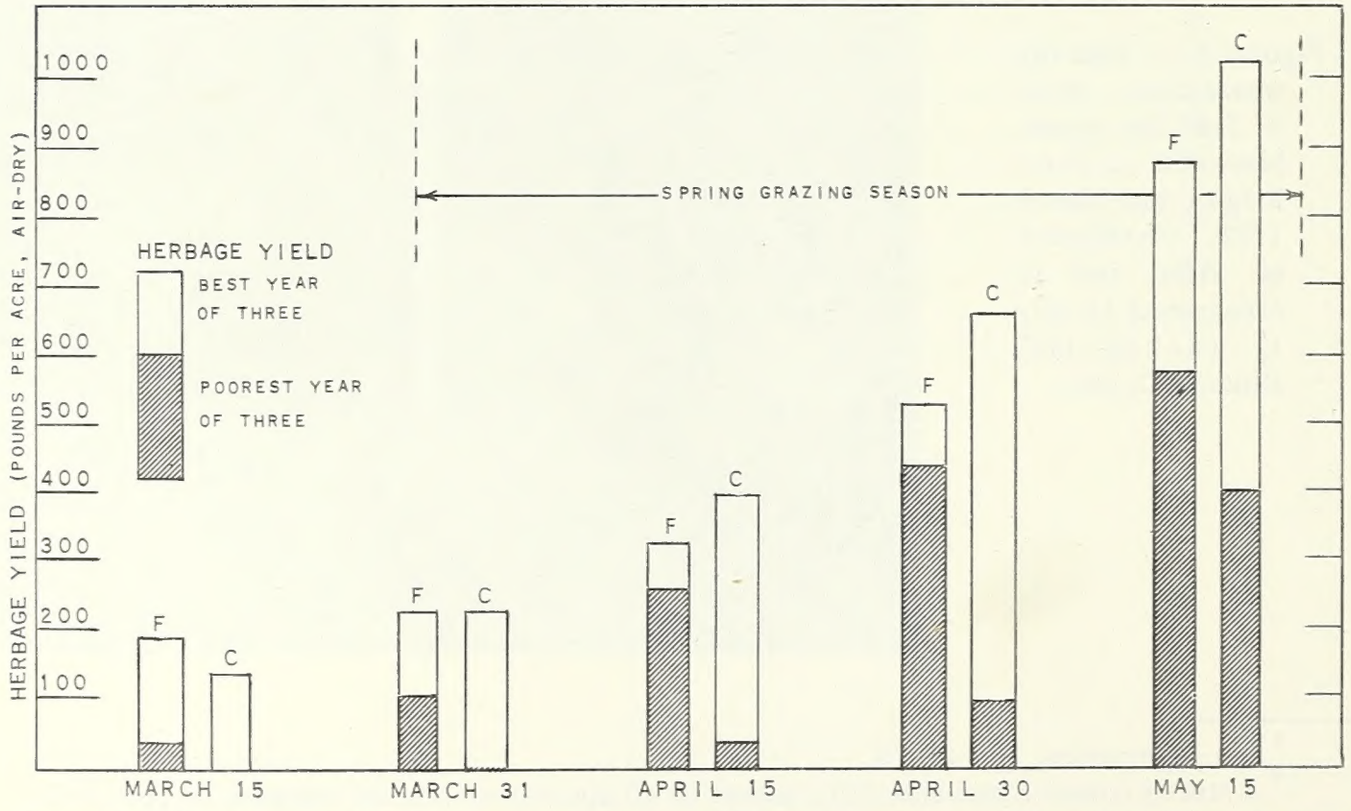

Figure 3.--Herbage yield of fairway wheatgrass (F) and cheatgrass (C) on five dates in spring, showing highest and lowest yields for each date in 1948, 1949, 1950. Elmore County.

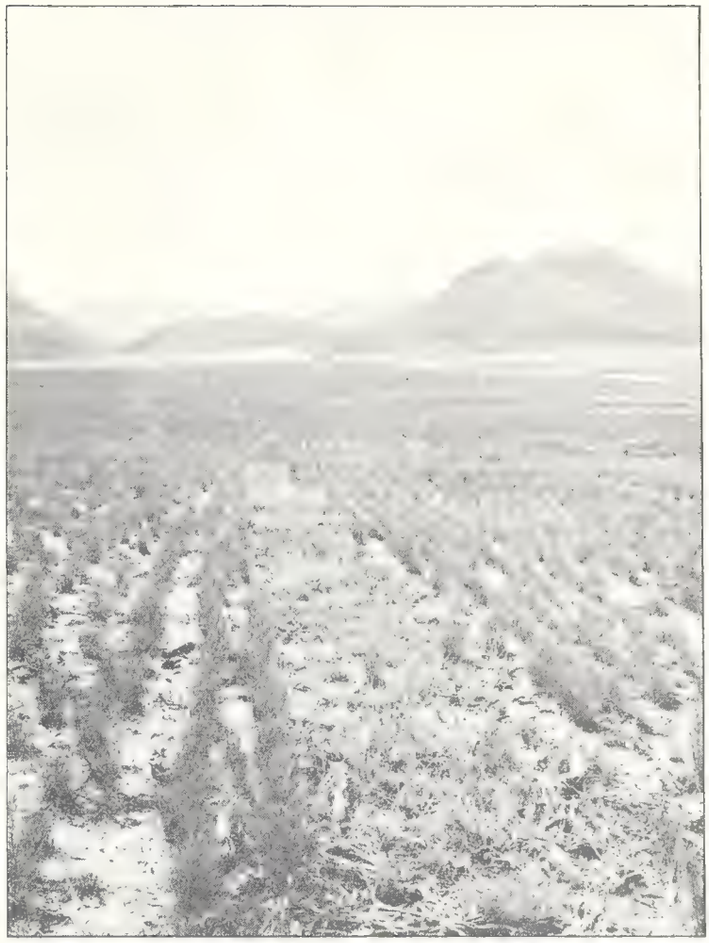

Figure 4.--A good stand of crested wheatgrass suppresses and replaces halogeton except in the drill "skip." Cassia County.

CONSIDERATIONS PRELIMINARY TO SEEDING

To be a sound investment, seeding should be done only where the anticipated returns would justify the expense. Usually, returns are measured in forage quantity or quality, or in livestock products. Sometimes the benefit may be control of poisonous or otherwise undesirable plants, improvement of watershed or of wildlife habitat, or a reduction of fire hazard. The decision to seed a range should be made only after considering the questions that follow:

1. Is seeding needed for improvement?--The major consideration in deciding whether to seed is current production in comparison to the estimated potential of the range. On poor-condition ranges where some desirable perennials remain, reducing the grazing pressure or changing the season of use may permit native plants to increase and revegetate the range at only a fraction of the cost of seeding. Burning, spraying with herbicides, or mechanically destroying sagebrush, juniper, wyethia, or other undesirable plants may release desirable plants from competition and increase range productivity without seeding (Mueggler and Blaisdell 1951; Pechanec, Stewart, and Blaisdell 1954; Pechanec et al. 1964).

2. Can the site be worked?--Steep slopes and presence of rocks increase costs and limit the effectiveness of machinery used in seedbed preparation and planting. Unstable soils, broken up for seeding, may blow or wash; this could result in a seeding failure and create an erosion problem. Sands, rocks, or steep slopes may entirely preclude artificial revegetation.

3. Can success be expected?--Best returns come from depleted range areas with moderately level topography and deep fertile soils. Potential productivity of such sites is often indicated by the vigorous growth of undesirable plants. It is good business to seed the best sites first, and then proceed to less productive or harsher sites that are steep, rocky, dry, or saline.

Moisture is the major factor in success of seeding. Season of precipitation and the moisture-holding capacity of the soil both influence the effectiveness of rainfall; but, in general, wherever the average annual precipitation in Idaho is 11 inches or more, seeding has been successful. Where the annual precipitation averages from 9 to 11 inches, success can reasonably be expected, but an especially good job of seedbed preparation and planting is required. Several seedings have been successful in the 7- to 9-inch precipitation belt, but the percentage of successes is much lower than in wetter areas.

4. Can the area be managed?--Good range management is as important on seeded as on native range. Seeding can be a sound and durable investment only if the number of livestock and the season of grazing can be controlled. Fencing is usually an integral part of a seeding project.

5. Will returns justify costs?--Current seeding costs range from $5 to $25 per acre. Where the yearly production of usable forage can be changed from about 50 pounds or less per acre to 400 pounds or more, or the per-acre gain of livestock increased from 4 to 40 pounds or more, seeding is a profitable investment. With such increases, a range seeding costing $10 per acre would pay for itself during the third season of grazing, or about the fifth or sixth year after seeding. Many seedings have equaled or excelled this and are still productive after 20 to 30 years of grazing. Methods of calculating seeding costs and returns can be found in bulletins by Caton and Beringer (1960) and Lloyd and Cook (1960).

6. Will wildlife values be damaged?--Browse is the primary sustenance of big game animals in winter, and shrubs provide the cover essential to good habitat of game animals and birds. Before converting a brushy site to grass by seeding, the range owner or manager should consider what effect such a change would have upon wildlife.

7. Can sound practices be applied?--Most of the past failures in range seeding could have been prevented if certain procedures necessary to success had been followed. Experience and research have demonstrated four principles to be fundamental to seeding success:

a. Vegetation that competes with seeded species for moisture must be eliminated.

b. Planting must be at the time, depth, and rate that are best for emergence and survival of seedlings.

c. Only species suited to the site should be seeded.

d. The resulting stand must be managed to assure sustained maximum productivity.

REMOVAL OF COMPETING VEGETATION

Stands of undesirable plants use the soil moisture needed for establishment and survival of seeded species; this has been demonstrated in cheatgrass, big sagebrush, mountain meadows, and other types in the Intermountain region (Blaisdell 1949; Hull and Stewart 1948; Mueggler and Blaisdell 1951). The more the competing vegetation is reduced, the better the stand of seeded plants will be.

The competitive effect of sagebrush on grass was shown by results of an experiment near Malta, in Cassia County, where an area was subjected to treatments that removed different amounts of sagebrush before seeding. Before treatment, the area had 20 sagebrush plants per 100 square feet and was producing 50 pounds of native grass per acre. Railing twice killed 53 percent of the brush. Three years after treatment, the yield of native grass had increased to 210 pounds per acre and the seeded grass yielded 530 pounds for a total of 740 pounds of grass per acre. Railing once and burning killed 92 percent of the sagebrush. After this reduction, the native grass yield increased to 335 pounds per acre and the seeded grass yielded 1,785 pounds for a total of 2,120 pounds of grass.

At eight locations in southern Idaho, crested wheatgrass or intermediate wheatgrass or both were drilled in the fall of 1954 in standing sagebrush and on adjacent areas where sagebrush had been plowed. Seeded plants emerged equally well on plowed and unplowed areas, but by the third growing season there were 20 times more well-established grass plants in the plowed area--an average of 1.6 plants per square foot. The average height of the grass in the sagebrush was only one-fifth of that where sagebrush had been eradicated.

Southeast of Boise, perennial grasses were drilled for 4 years where burning at different seasons had reduced the cheatgrass by varying amounts. Seeded species emerged equally well in all cheatgrass densities, but as cheatgrass was reduced from an average of 1,325 plants per square foot to 21 plants, survival of the seeded grass after 5 years was improved from almost none to 1.7 plants per square foot (Hull and Stewart 1948).

SEEDING PROCEDURES

METHOD

The seeding method to be used will be governed by the topography, soil, and the treatment used to remove competing vegetation. The best method will distribute seed uniformly and at the most favorable depth for successful seedling emergence and survival.

Drilling is the best method for attaining both of these goals; and wherever a drill can be used, it should be. Double disk drills are satisfactory for well-prepared, trash-free seedbeds. For most range seedings, however, the single-disk drill has a wider range of adaptability. Where the seedbed is loose, a depth-regulating band can be attached to the furrow-opening disks of single-disk drills to prevent seeding too deep (fig. 5).

Deep-furrow disk or shovel-type drills place the seed at the bottom of furrows, where moisture conditions favor germination and growth of seedlings. They also suppress small weeds on either side of the furrow by covering them with soil. Deep furrows are not desirable on sites where they would be flooded or would be filled with soil by blowing, washing, or sloughing. On sloping lands, furrows should be on the contour.

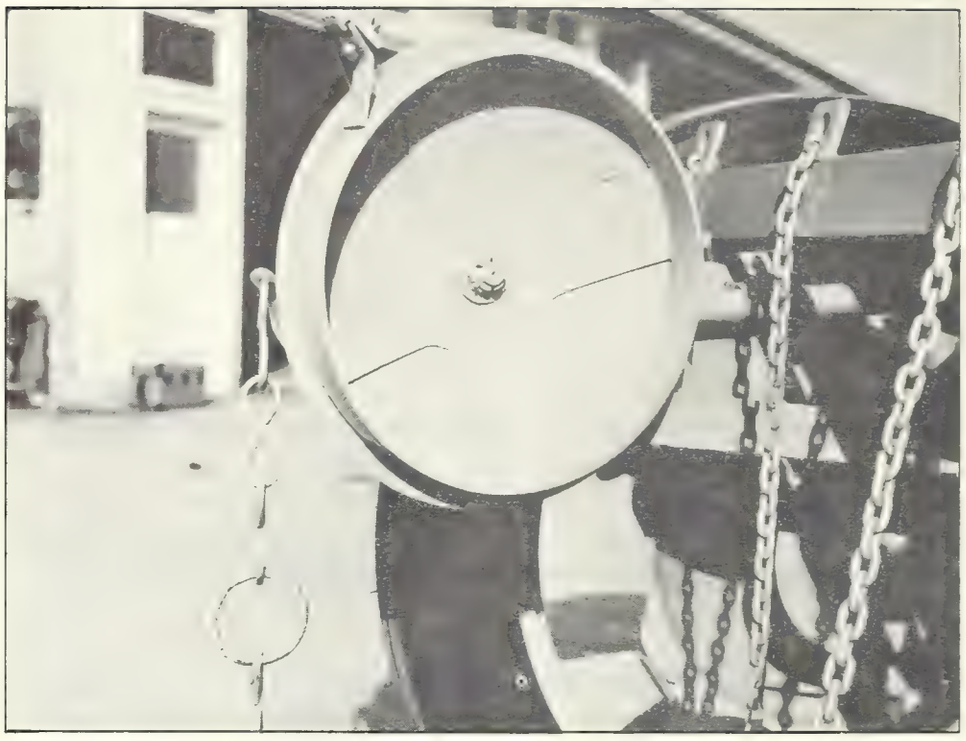

Figure 5.--The Rangeland drill recently developed by Federal agencies for seeding rough, rocky ranges. The circular metal flange prevents penetration of the furrow-opening disk beyond optimum depth of seed placement. Furrow openers have flexibility of movement that permits the drill to roll over large obstacles without breakage.

Seeds of most grasses can be fed from the grain hopper of the drill with cups on the "wheat" setting. Small seeds such as clover, alfalfa, and timothy, can be seeded from the small "grass seed" hopper attached to most grain drills (Plummer et al. 1955).

Broadcasting usually wastes seed because it distributes it poorly. Also, broadcast seed may be covered unevenly or not at all. However, broadcasting may have to be used where drilling cannot be done because of steepness, rockiness, or trees. Broadcast seed should be covered. Some covering can be accomplished by a harrow, chain, brush drag, or hand rake. Under a few conditions broadcast seed is covered by natural means. On all but sandy soils, seed broadcast immediately on newly turned ground is covered as the fresh clods break up and the soil settles. On timber and brush burns, a deep layer of fresh ashes covers seed if broadcasting is done before the ashes are packed down by rains. Sagebrush ashes are seldom deep enough to cover broadcast seed.

The disadvantage of broadcasting is shown by comparing it with drilling on freshly plowed seedbeds at eight locations in southern Idaho in 1954. When these seedings were 2 years old, crested wheatgrass plants averaged 1.4 plants per square foot and produced 487 pounds of herbage, air-dry, per acre on drilled plots; on broadcast-seeded plots, with the same amount of seed per acre (Hull 1959), the averages were 0.5 plant per square foot and 182 pounds of herbage per acre.

Broadcasting seed in pellets of compressed earth or coated seed pellets has attracted much attention. The compressed earth pelleting operation damages the seed, and poor stands have resulted on all areas seeded by these pellets (Tisdale and Platt 1951; Moomaw et al. 1954).

Coated pellets have given results comparable to those for broadcast naked seed; but without soil covering, poor stands or failures result for both (Hull 1959). A survey of all range seedings with pellets showed that none was successful and that pellet seeding of rangelands could not be recommended (Hull et al. 1963).

DEPTH

For best emergence and survival, seed should be placed at a depth related to seed size. As depth increases beyond optimum, fewer seedlings can emerge. At shallower depths, germination decreases and seedling mortality increases. The sustaining secondary root system of grasses arises from the shoot above the level of the seed. When the seed is too shallow, the secondary root system either fails completely or develops very slowly. With no secondary root system the plant also is inadequately anchored and may be blown over or broken off. Recommended depths for different species are shown in table 3 (pp. 12-14).

SEASON

Planting should be timed so that seedlings will start to germinate and emerge at the beginning of the longest period of favorable soil moisture and temperature. A review of results in southern Idaho shows that fall seedings have produced consistently better stands than spring seedings.

October seedings are usually somewhat more successful than September seedings (Hull 1948). At high elevations, of course, seeding must be early enough to be completed before winter starts.

Spring seedings have been successful, but they have several limitations. Spring rains interrupt work, areas dry unevenly, and the favorable season for seeding is usually short. In western Idaho, there may be no spring or summer rain after the ground becomes dry enough for cultivation.

RATE

The amount of seed to use varies with species and seeding method. If planting techniques could provide even distribution and insure the development of a mature plant from every seed, then less than a pound of seed per acre would be sufficient to establish a seeded stand. But some seeds never germinate; some germinate and the shoots do not emerge; and some plants die after emergence. Seeding rates must compensate for these losses. Beyond what is required for establishing a full stand, however, increase in rate wastes seed. Each site can support only a limited maximum number of mature plants; if more than that emerge, the excess will die.

In Elmore County, for example, yields from plots seeded at rates of 1 and 40 pounds of fairway wheatgrass seed per acre were essentially the same when the seedings were 10 years old (table 1). Similar results were obtained in Clark and Bonneville Counties (Mueggler and Blaisdell 1955).

Table 1.--Fairway wheatgrass plants per square foot and herbage yields from seeding at rates of 1 to 40 pounds per acre, Elmore County

Seeding rate	First year seedlings	Fourth year plants [1]	Mortality	Tenth year yields
Lbs./acre	Number		Percent	Lbs./acre
1	0.7	0.7	0	690
2	1.9	1.0	47	685
4	3.5	1.0	71	705
6	5.0	1.3	74	770
8	7.5	1.4	81	800
10	9.5	1.5	84	715
20	19.0	1.9	90	520
40	37.5	2.0	95	700

[1] It was difficult to count plants older than 4 years.

Although plant numbers equalize over several years' time, low seeding rates have three inherent disadvantages:

1. Stands require longer time to reach full productivity.

2. A thin stand is more subject to invasion by undesirable species than a thick stand.

3. Where original seedling density is low, plant distribution is irregular, robust and relatively unpalatable plants tend to develop, and subsequent grazing is uneven.

Recommended seeding rates for drilling (table 3) should be increased to compensate for the nonviable and impure seed and for deficiencies in seeding techniques. A common practice is to increase the rates shown by 50 percent for broadcast seeding.

ROW SPACING

Spacing of seeded rows normally ranges from 6 to 24 inches. Tests in Oneida, Clark, and Elmore Counties showed no difference in ultimate herbage yield of stands seeded at any row spacing up to 2 feet. As the rows are spaced farther apart, less seed is required, but more years are required to attain full production. Close spacing helps to inhibit invasion by undesirable plants during the early years after seeding. The wider the space between rows, the coarser the plants, and with some species, the less palatable.

The most suitable distance between drill rows on the drier Idaho rangelands is 10 to 12 inches. On moister sites, drill rows should be 6 to 8 inches apart.

SELECTION OF SPECIES TO SEED

CHARACTERISTICS OF SPECIES

Many features contribute to or detract from a species' value for seeding. Ability to survive and grow on the site to be seeded is of first importance; this has been well established for all species and types of sites discussed herein. Additional considerations that influence a choice of species for a particular site and purpose include competitive ability, longevity, palatability and grazing tolerance, and distinctive growth habits such as those mentioned in table 3.

Competitive Ability

A species should be able to prevent or inhibit invasion by undesirable plants. Grass species vary markedly in this ability. Following are two examples of such differences from Cassia and Oneida Counties. At Meadow Creek, Cassia County, crested wheatgrass and intermediate wheatgrass were seeded on adjacent parts of a favorable sagebrush site in 1948. Vegetation was mainly big sagebrush with some serviceberry and snowberry. Good stands of both grasses started, and many seedlings of sagebrush came up among the grass seedlings. Some sagebrush seedlings died, but 14 sagebrush seedlings per 100 square feet became established in the crested wheatgrass and 19 in the intermediate wheatgrass. In the crested wheatgrass area, subsequent establishment of sagebrush plants increased their number to 15 in 1955 and to 17 in 1962. But in the intermediate wheatgrass, sagebrush plants increased to 46 in 1955 and 96 in 1962. Crested wheatgrass suppressed the growth rate of sagebrush that became established the same year as the grass and subsequently allowed establishment of only a few additional plants. On the other hand, intermediate wheatgrass inhibited neither the continued establishment of sagebrush nor its vigorous growth. The production of intermediate wheatgrass was much less in 1962 than in 1955, while crested wheatgrass yielded the same amount of herbage both years.

Near Holbrook, Oneida County, crested wheatgrass and bluebunch wheatgrass were seeded on adjacent areas on abandoned farmland in the fall of 1939. Both grasses established a good seedling stand. For 25 years, crested wheatgrass has maintained a good stand under moderate to heavy grazing, and has allowed only negligible sagebrush reinvasion. Bluebunch wheatgrass, on the other hand, gradually disappeared and has been completely replaced by a mixed stand of crested wheatgrass and big sagebrush. Obviously, the more competitive grass, which inhibits establishment or growth of brush, allows a greater interval of time until the seeding requires brush control.

Longevity

Another important consideration in selecting species to seed is longevity of plants. Ideally, range seeding is a one-time operation that will last indefinitely with good management.

Longevity of seeded stands is often questioned. Although yields vary with year-to-year climatic deviations, production generally increases for 2 to 5 years after planting. Later, production characteristically declines to what seems to be the level of sustained productivity for the site. Crested and fairway wheatgrasses, smooth brome, and bulbous bluegrass have produced for more than 25 years on sites to which they are adapted. The oldest known seedings of crested wheatgrass in Idaho that have been grazed regularly were made in 1932 and 1933. At the end of 30 years these stands were still productive and yielded far more palatable herbage than adjacent unseeded ranges. The highest recorded yield was produced in the 30th growing season for a 1933 seeding near Dubois, Clark County, and during the 20th season for a 1943 seeding near Sublette, Cassia County (table 2). These high yields in 1963 followed favorable precipitation in 1962.

Table 2.--Yields of crested wheatgrass in air-dry herbage from seedings near Dubois (1933) and Sublette (1943)

Year	Dubois	Sublette	Year	Dubois	Sublette
	Lbs./acre			Lbs./acre	
1941	729	-- [1]	1953	--	--
1942	665	--	1954	--	--
1943	--	--	1955	1,005	700
1944	--	--	1956	856	860
1945	--	1,274	1957	--	1,160
1946	--	1,785	1958	--	1,280
1947	785	1,267	1959	--	820
1948	685	840	1960	--	700
1949	800	820	1961	--	640
1950	675	700	1962	1,316	1,790
1951	555	990	1963	2,016	2,173
1952	560	941	1964	1,268	1,746

[1] Dash (--) indicates no observation.

Palatability and Tolerance to Grazing

Palatability is important where there are two or more species in the same grazing area. Unless they are similar in palatability, the more palatable will suffer from heavy use (fig. 6). If stock are forced to eat only a moderate amount of the less palatable, the more palatable species is weakened.

Some species are better adapted to survive heavy grazing than others, but productivity of any species is reduced by continued heavy use.

SPECIES FOR SOUTHERN IDAHO RANGES

From more than 250 species and strains tested on a variety of sites in southern Idaho, enough have been found to fit almost all kinds of sites needing revegetation from the low-rainfall areas to the high mountains. Recommended species are listed in table 3. A complete list of species tested in southern Idaho is in the Appendix. Further information about species characteristics is given by Hafenrichter et al. 1949; Plummer et al. 1955; Stark et al. 1950; and Weintraub 1953.

A

B

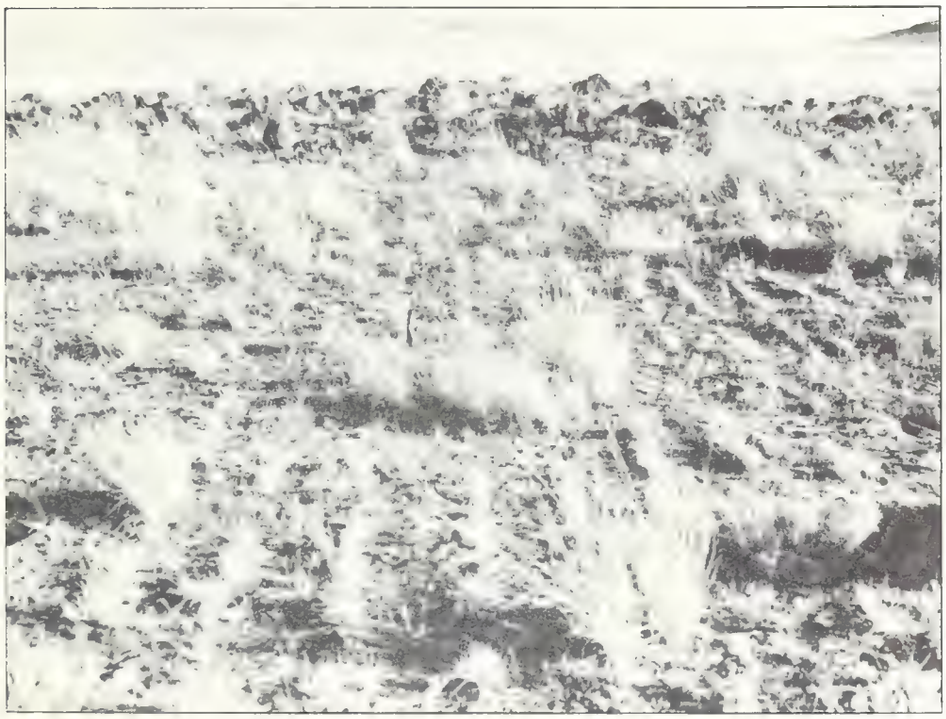

Figure 6.--Differences in palatability create problems of grazing management: A, Two grass species growing in alternate drill rows. Sheep utilized about 70 percent of the intermediate wheatgrass but scarcely any of the beardless wheatgrass. Elmore County. B, Cattle grazed crested wheatgrass close to the ground in spring but took very little of the native beardless wheatgrass. Lincoln County.

Table 3.--Species recommended for seeding rangelands in southern Idaho; characteristics, suggested planting depths and seeding rates[1] for drilled seedings, and sites recommended

Species, planting depth, and rate	Description	Recommended sites
Alfalfa		
1/4 inch; 1 to 2 pounds per acre, in mixture with grass.	Productive and palatable introduced legume. Vulnerable to pocket gophers because of taproot. Creeping varieties are less susceptible to damage by rodents. Not persistent when grazed on rangelands. Seed should be inoculated with nitrogen-fixing bacteria. Should be seeded in spring. Not shade tolerant.	Intermediate[2] and favorable sagebrush, mountain-brush, and ponderosa pine sites. Poor at higher elevations in west-central Idaho.
Bluegrass, big		
1/4 to 1/2 inch; 4 to 5 pounds per acre.	Long-lived native bunchgrass. Yields much palatable foliage early in spring, but becomes unpalatable earlier than most grasses. Seedlings relatively low in vigor. Requires 4 to 8 years to reach full productivity. Because young plants are easily pulled up, grazing should be deferred until roots are well anchored. Somewhat shade tolerant.	Intermediate and favorable sagebrush sites. Sunny places on mountain-brush and ponderosa pine ranges. Meadows at lower elevations.
Bluegrass, bulbous		
Surface to 1/2 inch; 5 to 10 pounds per acre, the higher rate for broadcast seeding.	Small introduced bunchgrass, very palatable in spring. Grows rapidly in early spring and dries up before summer. Resumes growth in fall. Not highly productive. Because it can become established when broadcast without other treatment, it is useful on sites that cannot be tilled. Shade tolerant.	Sagebrush sites (except the driest), mountain-brush, and ponderosa pine. Especially the basaltic soils between Payette and Weiser Rivers. Not recommended for southeastern Idaho.
Brome, meadow		
1/2 to 1 inch; 6 to 10 pounds per acre.	Long-lived bunchgrass. Reaches full productivity in 2 or 3 years. Moderately palatable. Shade tolerant.	Favorable sagebrush sites and higher ranges. Meadows.
Brome, mountain		
3/4 to 1 inch; 8 to 10 pounds per acre.	Short-lived vigorous native bunchgrass. Reaches full productivity in 1 to 3 years. Volunteers well in some situations. Moderately palatable. Valuable for quick cover. Will be replaced by long-lived species in mixtures. Susceptible to smut.	Weedy openings at high altitudes and on timber burns.
Brome, smooth		
1/2 to 1 inch; 8 to 12 pounds per acre.	Long-lived introduced sod-forming grass. Very palatable and productive. Seedlings not vigorous, but once established, plants spread vegetatively to provide full stands. Notable ability to suppress reinvasion of undesirable vegetation. Shade tolerant.	Southern strains best for mountain-brush and favorable sites in the sagebrush zone. Northern strains have been best on higher elevation mountain rangelands. Meadows.

[1] Rates should be adjusted for other seeding methods (see pages 5 ff.) and for mixtures (see page 15).

[2] The adjectives "intermediate" and "favorable" describing sagebrush sites are defined in the text, pages 17 and 18.

Table 3.--(con.)

Species, planting depth, and rate	Description	Recommended sites
Fescue, Chewings		
1/4 to 3/4 inch; 3 to 5 pounds per acre.	Fine-leaved introduced bunchgrass. Low forage production. Remains green throughout the summer. Numerous roots make it a valuable soil stabilizer. Palatable early and late in the growing season. Shade tolerant.	Mountain-brush and higher ranges. Best results on dry meadows and timber burns at high altitudes.
Foxtail, meadow		
1/4 to 1/2 inch; 2 to 4 pounds per acre.	Introduced bunchgrass. Moderately palatable. Begins growth early in spring; leaves remain green until after hard frosts in late fall. Volunteers readily on sites where adapted.	Wet and dry meadows, and most high-elevation ranges.
Oatgrass, tall		
1/4 to 1 inch; 4 to 6 pounds per acre.	Short-lived introduced bunchgrass. Reaches full production very early. Moderately palatable. In some locations can maintain stand many years by volunteer seeding. Shade tolerant.	Mountainous areas, especially aspen, timber burns, ponderosa pine, and mountain-brush.
Orchardgrass		
1/4 to 3/4 inch; 3 to 5 pounds per acre.	Long-lived introduced bunchgrass. Very palatable, especially in early part of season. High yields. Very shade tolerant.	Favorable mountain-brush and mountain lands except dry south exposures. Especially valuable for aspen and other shady sites.
Timothy		
1/4 to 1/2 inch; 2 to 3 pounds per acre.	Short-lived introduced bunchgrass. Forms quick cover. Volunteers readily. Moderately palatable. High yields. Can be broadcast successfully. Shade tolerant.	Mountain sites. Ponderosa pine zone and above. Meadows.
Wheatgrasses, beardless and bluebunch		
1/2 to 1 inch; 6 to 10 pounds per acre.	Long-lived, native bunchgrasses. Begin growth early in spring, and again in fall after rains. High producers. Require several years for stands to attain full productivity. Moderately palatable. Slightly shade tolerant.	Intermediate and favorable sagebrush sites, mountain-brush, ponderosa pine, and juniper-pinyon ranges.
Wheatgrass, crested		
1/2 to 1 inch; 5 to 8 pounds per acre.	Long-lived, drought-enduring, introduced bunchgrass. Begins growth very early in spring. Dormant in late summer. Greens up again in the fall. Vigorous seedlings. Palatable in spring and late fall; rather unpalatable after seed formation. Withstands heavy grazing. Slightly shade tolerant.	Sagebrush, ponderosa pine, mountain-brush, and juniper-pinyon ranges. Low vigor and poor stands at elevations above 5,500 feet in western Idaho or 6,500 feet in eastern Idaho.

Table 3.--(con.)

Species, planting depth, and rate	Description	Recommended sites
Wheatgrass, fairway		
1/2 to 3/4 inch; 5 to 7 pounds per acre.	Similar to crested wheatgrass, but its finer stems and leaves are conducive to more uniform grazing. Shorter than crested. Matures a week or more earlier than crested wheatgrass. Slightly shade tolerant.	Same sites as above, but grows well at higher elevations than crested wheatgrass.
Wheatgrass, intermediate		
1/2 to 1 inch; 7 to 10 pounds per acre.	Long-lived introduced sod-forming grass. Vigorous, rapidly developing seedlings. Begins to grow very early in spring. Remains green and palatable into summer. High producer. Does not mature seed at high elevations, but spreads vegetatively. Moderately shade tolerant.	From intermediate sagebrush sites into the high mountains, and on dry meadows. Good for granitic soils in west-central Idaho.
Same.	Amur, a strain of intermediate wheatgrass, has vigorous seedlings.	Same.
Wheatgrass, pubescent		
1/2 to 1 inch; 7 to 10 pounds per acre.	Long-lived, introduced sod former. Similar to intermediate wheatgrass, but is somewhat more drought-resistant, and matures about a week earlier. Not shade tolerant.	From intermediate sagebrush sites into the high mountains, but not in meadows and shady areas.
Wheatgrass, slender		
1/2 to 1 inch; 6 to 8 pounds per acre.	Short-lived native bunchgrass. Vigorous seedlings. Volunteers aggressively. Forms a quick cover, but usually is replaced by other species. Moderately palatable. Many strains. Shade tolerant.	High-altitude ranges and more favorable sites on mountain-brush areas.
Wheatgrass, tall		
1/2 to 1 inch; 6 to 10 pounds per acre.	Long-lived robust introduced bunchgrass. Vigorous seedlings. Starts growth early in spring; matures in late summer. Useful for summer grazing on drylands at low elevations. Poor to fair palatability. Old coarse growth often makes current growth unavailable. Tolerant to salt, alkali, and water, but not to shade.	Salty areas such as greasewood and saltgrass sites, where the water table is from a few inches to several feet below ground surface. Also intermediate and favorable sagebrush, mountain-brush, and juniper sites.
Wildrye, Russian		
1/2 to 1 inch; 4 to 8 pounds per acre.	Long-lived introduced bunchgrass, producing abundance of basal leaves. Is palatable even when dry. Endures close grazing better than most grasses. Grows rapidly in spring, renews growth in fall. Erratic in establishment. Has low seedling vigor. Withstands drought, once it is established. Provides poor soil protection.	Sagebrush, mountain-brush, and juniper sites. Useful on soils too alkaline for fairway or crested wheatgrass, and too dry for tall wheatgrass. Because of poor establishment, not recommended for western Idaho.

Hull, A. C., Jr., and Ralph C. Holmgren.
1964. Seeding southern Idaho rangelands. U.S. Forest Serv. Res. Paper INT-10, 32 pp., illus.

Reports results of testing adaptability of more than 230 grass species for seeding rangelands in 33 counties in southern Idaho. Describes adapted species and recommends appropriate sites, seeding depths, and seeding rates.

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MIXTURES

Most lowland ranges having fairly even terrain and uniform soil conditions are best seeded to single species. A single species is easier to seed, more uniformly palatable, and easier to manage than a mixture. Species that differ markedly in palatability, growth rate, and green growth periods, can be sown in different units so that grazing can be rotated among them.

In mountainous or other areas having a variety of soil and moisture conditions, mixtures are recommended (Plummer et al. 1955). Short-lived fast-developing species seeded in mixtures with species that are longer lived but slower developing are useful for preventing erosion and for controlling undesirable plants during the first year or two after seeding while the slower growing plants are still small.

The amount of seed of each species to be planted in the mixture should be less than that recommended in table 3. A safe rule to follow in order to have sufficient seed of the adapted species on local sites where other components of the mixture will not become established is to compute the proportional amount from the table, using the highest value shown. For example, if it is desired that crested wheatgrass compose about half of the total mixture, use 4 rather than $2\frac{1}{2}$ pounds of seed of that species per acre in the mixture.

MANAGEMENT OF SEEDED RANGES

Seedings need total protection until plants are well established. A safe rule is to withhold grazing until after the first seed crop has matured and then to permit only light grazing late that season. This usually means that a seeding will be grazed for the first time during its second or third growing season.

Grazing too early in the life of a stand or too heavily year after year reduces the number of plants, lessens their vigor and productivity, and encourages invasion by undesirable weeds and brush. With mature stands of crested or fairway wheatgrasses on relatively level lands, about 40 percent of the herbage volume should be left ungrazed if the grass is to maintain vigor and high production. This utilization is heavier than is advisable for most native grasses. On sloping lands, to provide litter for prevention of erosion and enhancement of percolation of moisture into the ground, more unused herbage must be left on the ground than is required on level lands. Few grazing trials have been made on other seeded species, but observations show that most of them should be more lightly grazed than crested wheatgrass.

Sagebrush often becomes reestablished on grass seedings, especially during the first year when seeded plants are small and unable to suppress the reinvasion. Small sagebrush plants have little importance (fig. 7), but as the shrubs grow and give the seeding a brushy aspect, they reduce herbage production and accessibility of feed.

Reinvading sagebrush can be controlled by beating, cutting, or burning, or by applying chemical herbicides. These treatments are described below under "Site Preparation and Seeding." Beating is feasible if the ground surface is relatively free of rocks and if the sagebrush has attained a rather robust size with few branches or small plants below 6 inches. Herbicides and fire can be used on sagebrush of all ages. Burning should be planned to prevent injury to the seeded species. This can be accomplished by allowing litter to accumulate by grazing lightly for a year or two and then burning late in the season--preferably while the soil is damp.

After sagebrush control, the forage plants should be grazed only lightly or late for at least one season.

Figure 7.--Young sagebrush in a seeding of crested wheatgrass. These small shrubs neither obstruct grazing animals nor compete seriously for moisture. In a few years they will dominate the seeding unless they are controlled.

RECOMMENDATIONS FOR SPECIFIC RANGE TYPES

The natural vegetation is usually a good indicator of whether the climate and other site factors are favorable; thus it helps in selecting species to be seeded. The type of vegetation to be removed, of course, chiefly determines the method of site preparation for seeding.

Seeding trials have been conducted in most depleted range types in southern Idaho. Desirable species and effective methods have been determined for most range types, except the salt-desert shrub ranges. The following sections describe where artificial revegetation is possible and recommend species and seeding procedures.

SAGEBRUSH LANDS

Sagebrush occupies the largest acreage of range suitable for seeding in Idaho. Big sagebrush dominates, but threetip sagebrush occupies large areas in southeastern Idaho. On shallow soils underlain by rock or other impervious strata, low sagebrush is locally dominant. Other shrubs often associated with sagebrush are rabbitbrushes, bitterbrush, and horsebrush.

Species to Seed

Sagebrush sites in Idaho can be divided into three classes for the selection of species to seed: (1) harsh, (2) intermediate, and (3) favorable.

Harsh sites, where rainfall is generally less than 9 inches, are usually identifiable by presence of low-stature big sagebrush and by Sandberg bluegrass, squirreltail, or Thurber needlegrass. Remnants of Great Basin wildrye are found in swales and mounds of deeper soil. Bluebunch wheatgrass is rarely found, and arrowleaf balsamroot is absent. On sandy areas needle-and-thread and Indian ricegrass sometimes occur. Nearby saline lands may support stands of shadscale, winterfat, or Gardner saltbush.

Low sagebrush, although usually found in southern Idaho where rainfall is greater than on sites just described, is indicative of shallow soils that limit moisture storage. For this reason, sites below 7,500 feet elevation that support low sagebrush usually should be classed as "harsh" regardless of how much moisture they receive. Conditions favoring seedling establishment on harsh sites are uncertain, especially in dry years. Even when the most careful planting procedure is used, failure can be expected in about 1 year out of 3.

Only crested and fairway wheatgrasses have consistently shown themselves to be adapted. Siberian wheatgrass has the same adaptability as crested wheatgrass and can be used wherever crested wheatgrass is recommended. In eastern Idaho, Russian wildrye has yielded well, but its establishment is less dependable than that of the wheatgrasses.

Intermediate sites in the sagebrush zone have 9 to 14 inches of rainfall and are identifiable by presence of vigorous big or threetip sagebrush. In the upper levels of this zone, dryfarming has been successful. Where undisturbed, arrowleaf balsamroot is often an important component of the vegetation. Bitterbrush and prairie junegrass are usually present, and Idaho fescue often grows on north exposures.

Crested, Siberian, and fairway wheatgrasses are useful on these intermediate sites. Russian wildrye produces well but is difficult to establish. Two sod formers, intermediate and pubescent wheatgrasses, produce more on some of these sites than do crested or fairway wheatgrass. The Amur strain of intermediate wheatgrass has had only limited testing, but shows promise. Big bluegrass, tall wheatgrass, and bluebunch (including beardless) wheatgrass have produced well on some areas. Bulbous bluegrass is useful where broadcasting is the only possible method of seeding. Alfalfa can be included in mixture with grasses when seeding is done in the spring.

Yields of some seeded grasses on these intermediate sagebrush sites are shown in table 4.

Table 4.--Yield per acre in pounds of air-dry herbage of six species on "intermediate" sagebrush sites in southern Idaho in 1955, 1962, and 1963

Location	Crested wheatgrass			Fairway wheatgrass			Intermediate wheatgrass			Pubescent wheatgrass			Russian wildrye		
	1955	1962	1963	1955	1962	1963	1955	1962	1963	1955	1962	1963	1955	1962	1963
Eastern Idaho															
U.S. Sheep Expt. Station, Clark County	1,056	1,299	1,738	942	1,060	2,238	898	1,198	2,037	869	1,287	2,238	705	668	1,794
Michaud, Power County	660	796	1,920	--	--	--	990	1,484	2,020	960	1,425	2,170	667	566	440
Southern Idaho															
Almo, Cassia County	580	1,043	2,013	460	1,147	1,513	--	--	--	--	--	--	494	1,178	1,728
Southwestern Idaho															
Regina, Elmore County	800	424	1,181	562	390	835	699	250	567	786	407	729	424	403	324

Favorable sites are in the cooler, higher vegetational zones, where annual precipitation is usually greater than 14 inches. Most species recommended for the intermediate sagebrush sites are also adapted for the favorable areas; however, above 5,500 feet in western Idaho and 6,500 feet in eastern Idaho, crested wheatgrass has not been productive. Smooth brome and meadow brome become useful about where crested wheatgrass begins to fail. The best producers on these favorable sagebrush sites are smooth brome, and intermediate, pubescent, fairway, and tall wheatgrasses. Where silver sagebrush is common, the species and methods recommended are the same as for mountain meadows (see pages 22-23).

Site Preparation and Seeding

For successful establishment of seeded species, practically all of the sagebrush and other brush species associated with it must be eradicated. Big sagebrush is easily eradicated. When defoliated or burned, it dies and does not sprout from the base. Sagebrush seed ripens in the fall; therefore, areas should be treated before fall to lessen the likelihood of reestablishment of sagebrush.

Methods of controlling sagebrush are discussed in U.S. Department of Agriculture Agriculture Handbook 277, "Sagebrush control on rangelands," by Pechanec et al. 1964. Only a brief summary of eradication methods is given here.

The three general methods of sagebrush eradication use chemicals, fire, and mechanical equipment.

Chemical control is useful for releasing a good stand of seeded or native grasses from suppression by sagebrush. It is not entirely satisfactory, though, because it leaves some standing brush, which hinders planting grass. Inferior plants that are not destroyed by chemicals remain and compete with seeded plants for moisture.

Burning is an effective, economical method of controlling sagebrush. Carefully handled, fire can be a good tool; but improperly used it can damage soil and vegetation. Burning leaves a clean, firm seedbed that requires no further treatment before drilling the seed. U.S. Department of Agriculture Farmer's Bulletin 1948, "Sagebrush burning--good and bad" (Pechanec et al. 1954) describes burning techniques and necessary precautions.

Fire completely kills big sagebrush, but threetip sagebrush often resprouts. Low sagebrush can be killed by burning but it is often too sparse to carry a fire. Rabbitbrush and horsebrush sprout freely from the base and roots; so the number of plants often increases after a fire. Mechanical eradication should be used where any appreciable amount of these species is in the cover.

Almost every year wildfires occur in the sagebrush zone in southern Idaho. Many of these accidental burns leave seedbeds that provide excellent opportunities for seeding. They should be planted the year the burn occurs. Otherwise, undesirable plants will occupy the site and reduce the likelihood of successful establishment of seeded plants.

Mechanical eradication by plowing is recommended for sagebrush sites where burning is not feasible. The most common implements are disk-type plows such as the one-way single-axle disk (wheatland type) plow, the heavy offset disk, and the brushland plow. The brushland plow was designed for use on rough and rocky rangelands and is the only machine that can be used on such lands without undue breakage. Depth of plowing ordinarily should be from 2 to 4 inches, which is enough to destroy big sagebrush and most herbaceous species. A plowing depth of 4 to 6 inches is required to kill base- or root-sprouting species such as spineless horsebrush and rabbitbrush.

If cheatgrass is part of the understory, plowing should be done in the spring before it sets seed; otherwise, plowing merely plants the cheatgrass.

Other mechanical methods of eradication have been used successfully under certain conditions. Root cutters or root plows work well on rock-free sites to kill sagebrush and such root-sprouting plants as rabbitbrush. Railing and chaining are useful in tearing out old brittle brush, but they are ineffective on flexible young shrubs. Going over the same swath a second time in the opposite direction greatly increases the brush kill. Brush piled by railing and chaining can be burned to facilitate drilling.

The self-clearing pipe harrow is excellent for eliminating small brittle sagebrush in areas too rough or rocky to be plowed and for covering broadcast seed.

Rotary cutters and brush beaters effectively kill taller brush but leave young or low-lying shrubs and herbaceous plants undamaged. Cutters are most valuable to kill brush and thus to release desirable understory forage plants from competition for moisture and light.

WEEDY TYPES IN THE SAGEBRUSH ZONE

Cheatgrass, medusahead, Russian-thistle, halogeton, mustards, and other annual weeds occupy millions of acres of southern Idaho rangelands, mainly as a result of plowing and abandonment, burning, overgrazing, or other treatments that have killed part or all of the sagebrush and other native vegetation. These aggressive annual plants must be removed to obtain a clean seedbed before perennial grasses are planted.

Species to Seed

Species to seed on these weedy sites can be selected from those recommended above for similar sites on sagebrush lands.

Site Preparation and Seeding

Cheatgrass, a winter annual, is eliminated by treatments that prevent seed formation. Spring tillage, before seeds ripen, gives good control for one growing season. This is usually long enough to allow perennial grasses to become established. In years having enough fall moisture to assure good germination of cheatgrass, planting sites can be disked after fall germination. These sites can be plowed thoroughly with a moldboard plow whenever soil moisture conditions permit, since practically all the seed will be buried several inches deep.

Burning in early summer, before seed dispersal, has controlled cheatgrass the following year sufficiently to permit good establishment of perennials. For complete control, cheatgrass must be burned early, while still red--just before the tan color becomes prominent. Considerable litter from the previous year's growth is needed to help carry the fire this early in the season. If winter or spring germination is not complete, holdover seed is not damaged by an early fire.

Accidental summer burns destroy newly fallen seed if the fires are very hot; such clean, complete burns assure well-prepared seedbeds. Burns should not be planned for summer because they vary greatly in results and needlessly expose the soil to danger of erosion. Early burns, on the other hand, leave a thin turflike stubble as a protective ground cover.

Sandberg bluegrass competes strongly with planted seedlings and is little harmed by early fires; so considerable bluegrass in the cheatgrass cover indicates the need for some kind of tillage before seeding.

Medusahead, a range pest that has replaced cheatgrass in some parts of western Idaho, is a grass similar to cheatgrass in growth habit and life history. Preliminary experiments with medusahead have shown its response to several eradication treatments to be similar to that of cheatgrass; but too few tests have been made of eradication of medusahead for us to make more than a tentative recommendation that it be treated like cheatgrass.

Russian-thistle, a summer annual, demands most soil moisture after perennial grasses are dormant. It offers little direct competition to seedlings of recommended seeded species. Grass seed usually can be successfully drilled among these weeds without any ground preparation.

Halogeton has growth requirements similar to those of Russian-thistle and can be treated the same way (Plummer et al. 1955). Seedings of perennial grasses in areas occupied by halogeton have not been successful where soils were heavy or saline and had not supported good sagebrush.

Mustards and other winter annuals grow early in the spring and compete more directly with planted seedlings than Russian-thistle does. Drilling in mustard stands without preparatory ground treatment has seldom resulted in successful seedling establishment. For best results, mustard stands should be plowed or disked in the spring before mustard produces seed.

Abandoned farmlands offer economical seeding opportunities. They require no seedbed preparation if seeding is to be done the first fall or early spring following the last harvested crop. If seeding is delayed, the treatment should be that recommended for the vegetation that invades the field.

JUNIPER LANDS

The juniper type is relatively minor in Idaho, but its potential for improvement is great. Species recommended for juniper and pinyon sites are those mentioned above for intermediate sagebrush sites.

Juniper sites with openings dominated by weeds or sagebrush should be treated as recommended for those types. Thick stands of old juniper and pinyon can be cabled or chained. Juniper with enough understory to carry a fire can be burned and the burns seeded in the same manner as suggested for sagebrush. Individual junipers can be burned with a flame thrower or pushed over and piled by a bulldozer.

MOUNTAIN BRUSHLANDS

Large areas of foothill and mountain country in southeastern Idaho support a "mountain brush" type, which includes bigtooth maple, bitterbrush, chokecherry, curlleaf mountain-mahogany, rubber rabbitbrush, serviceberry, snowberry, and snowbrush. Sagebrush is an important associate. Good-condition ranges have an understory of perennial grasses and palatable broad-leaved herbs. On depleted ranges the understory vegetation is mostly low-quality weeds and grasses. Where topography permits, such depleted mountain-brush ranges can be greatly improved by seeding.

Because browse in this zone is a valuable forage, especially for fall use by livestock and fall and winter use by big game, it may not always be desirable to destroy brush stands for seeding grass.

Species to Seed

This brush type varies considerably, but the species usually recommended for the intermediate and favorable sagebrush sites are adapted to this zone. Tall oatgrass has been successful on most mountain-brush seedings. Slender wheatgrass and Chewings fescue can be planted on many sites, and orchardgrass is successful in shady areas. Alfalfa grows well but is sometimes badly damaged by livestock grazing and by gophers. The most useful species are intermediate, pubescent, and fairway wheatgrasses--the latter two on the drier sites.

Site Preparation and Seeding

Mountain-brush sites, if dominated by weeds or low shrubs, especially sagebrush, should be treated like sagebrush lands. Plowing is necessary to kill sprouting shrubs such as snowberry.

The larger treelike mountain-brush species, such as maple and chokecherry, may be burned; seed may then be broadcast in the loose ashes. Resprouting trees and shrubs may eventually suppress the seeded species. If understory openings between the treelike plants are almost bare, seed can be broadcast in early fall and will be covered by falling leaves. Establishment under such conditions is slow, but fair to excellent seeded stands have been attained by this method (fig. 8).

PONDEROSA PINE FORESTS

The ponderosa pine forests of western Idaho are important primarily for their watersheds and for timber production, but they provide considerable grazing for livestock and big game. The common perennial understory forage plants are bitterbrush, bluebunch wheatgrass, Idaho fescue, and balsamroot. Fires and heavy use by livestock and big game have reduced the understory to cheatgrass in many places. Wherever these forests can be seeded, forage production is greatly increased in the timber openings (fig. 9). Seeding also reduces erosion hazards following logging and accidental fires in this zone and in the higher forests as well.

Species to Seed

Species recommended above for the mountain-brush sites are also useful on the ponderosa pine sites. Tall oatgrass, slender wheatgrass, and timothy produce quick cover, while smooth and meadow bromes and fairway, crested, intermediate, and pubescent wheatgrasses are long-lived for permanent forage. Orchardgrass is useful in shady places. A mixture of timothy,

Figure 8.--This good grass cover was attained by broadcasting seed in a nearly bare opening in maple at time of leaf fall and by providing protection through two seasons. Franklin County.

orchardgrass, smooth brome, and intermediate and fairway wheatgrasses, with variations, has been successfully established on logged areas in western Idaho. Establishment has been consistently better on the lava sites west of the Payette River than on the granitic soils east of the river.

Site Preparation and Seeding

Timber openings supporting cheatgrass, sagebrush, and mountain brush should be treated by using the same methods and species as recommended for the type of vegetation that occupies them.

Timbered areas disturbed by logging or accidental burns should be seeded immediately after logging or burning. Broadcasting is the only feasible method for seeding skid trails, steep slopes, and most burns. If seed is broadcast before rains pack the surface, it can be covered by soil slough or deep ashes. Roads and landings can be drilled, or the seed could be broadcast and later covered by harrowing.

MOUNTAIN MEADOWS

High elevation meadows usually contain varied types of vegetation. Some meadows have deteriorated to silver sagebrush or to undesirable broad-leaved perennials, mainly wyethia. If good forage plants occupy the space between the undesirable plants, it is usually sufficient to treat meadows with some herbicide and then to protect them a year or more to allow the species thus released from competition to improve in vigor and productivity. Some dry flats and dry meadows have been brought to high productivity by irrigation.

Species to Seed

Meadow foxtail, timothy, and smooth and meadow bromes have shown the most promise of sustained high productivity on the wettest parts of the meadow. In somewhat drier parts of the true meadow, these four species plus intermediate wheatgrass and Chewings fescue have performed well. Redtop, orchardgrass, tall, red, and sulcata fescues, Kentucky bluegrass, reed canarygrass, tall oatgrass, slender and pubescent wheatgrasses, mountain brome, alsike clover, and birdsfoot trefoil have established good stands on some sites for varied periods of time; but as they have not done consistently well in all tests, we cannot recommend them.

Figure 9.--Seeded grass in the ponderosa pine zone. Washington County.

Site Preparation and Seeding

Plowing is the best method of eliminating undesirable meadow plants that are not susceptible to chemical control. Plowing should be done as early in the season as the meadow is workable. A plowing depth of 6 inches is necessary to kill wyethia (Mueggler and Blaisdell 1951). Tough sods are hard to break and difficult to turn with a moldboard plow (fig. 10). Many plowed meadows must be disked several times in order to prevent air pockets beneath the surface. Sometimes it has been found desirable to plow a meadow and let it lie fallow and settle for a year and then replow or disk. Good seedbed preparation is expensive, but seeding can be profitable because the potential of improved meadows is also high.

OTHER HIGH-ALTITUDE RANGES

Above the ponderosa pine and mountain-brush types in the higher mountains are forests of Douglas-fir, aspen, lodgepole pine, other species of fir, and spruce. The more open forests and parklike openings are the principal summer ranges for cattle and sheep in Idaho. Seeding opportunities are limited by steep topography, rockiness, presence of trees, or short growing season. However, grazing values of thousands of acres of burned timber, depleted aspen, and weedy openings could be greatly increased by seeding.

Timber Burns

Forest fires leave the ground exposed to elements that cause erosion. Seeding a herbaceous cover helps to control erosion and provides forage while the timber stand reestablishes itself (fig. 11).

Seed should be broadcast on the loose ashes before they settle and become packed by rains; otherwise, the seed will not have enough cover and anchorage.

Any mixture for seeding the varied sites on burns should include short-lived perennials for quick cover and slow-maturing, long-lived species. A good mixture includes timothy, tall oatgrass, meadow foxtail, smooth and mountain bromes, and Chewings fescue.

Figure 10.--The tough sod of a meadow is difficult to break. Sometimes the sod-ribbon slides off the moldboard into the adjacent furrow without turning. Valley County.

Aspen Forests

The highlands of southeastern Idaho contain large stands of aspen. In many of these, heavy grazing has caused valuable understory grasses and broad-leaved herbs to be replaced by a sparse cover of undesirable weeds. Presence of trees limits the seeding method to broadcasting with no preparatory seedbed treatment. In both Utah (Plummer and Stewart 1944) and southeastern Idaho, unproductive aspen ranges have been seeded successfully by broadcasting before or during the time of aspen leaf fall. The layer of leaves adequately covers the seed. Grass species that have performed best on aspen sites have been timothy, orchardgrass, tall oatgrass, meadow foxtail, intermediate wheatgrass, and smooth brome.

Weedy Openings

Much of the nonforested part of the higher country in southern Idaho is infested with tarweed and knotweed. These areas are often gullied and are the source of runoff from snowmelt and from summer storms.

On many of these sites, the temperature of surface soil fluctuates so greatly each day that seeding trials have not been successful. Except on some tarweed areas, further study is needed before we can make sound recommendations for seeding.

Tarweed often dominates high-altitude openings to the near-total exclusion of other species. In eastern Idaho, where summer rainfall is quite dependable, tarweed ranges have been improved by seeding; but no good seeded stands have been established in tarweed areas in western Idaho. Germination of tarweed seed is nearly complete each spring; hence it can be eliminated for 1 or more years by shallow cultivation or by spraying with 2,4-D in spring before seeds develop. Seeding should normally be done in early spring when tarweed is eliminated. Where spring seeding is not feasible, tarweed areas may be cultivated or sprayed with 2,4-D in the spring and seeded in the fall.

Smooth and mountain bromes, timothy, meadow foxtail, orchardgrass, intermediate, pubescent, and slender wheatgrass, and tall oatgrass are adapted for seeding on tarweed sites.

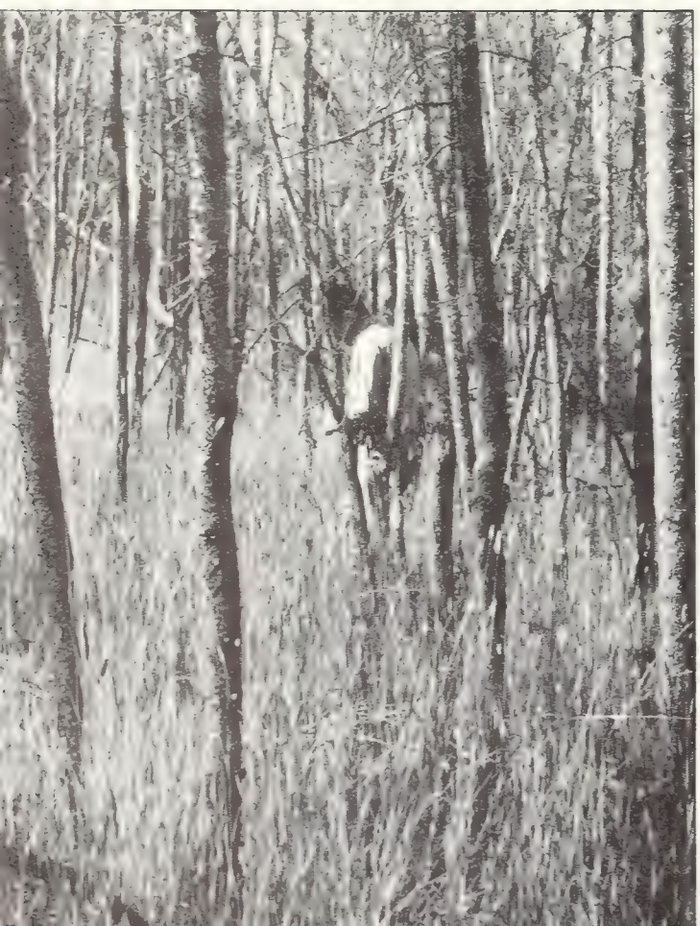

Figure 11.--Seeding this lodgepole pine burn has protected topsoil from erosion and provided feed for livestock and elk. Valley County.

LIST OF PLANTS

Common name	Scientific name
alfalfa	Medicago sativa L.
aspen	Populus tremuloides Michx.
balsamroot, arrowleaf	Balsamorhiza sagittata (Pursh) Nutt.
bitterbrush	Purshia tridentata (Pursh) DC.
bluegrass, big	Poa ampla Merr.
bluegrass, bulbous	P. bulbosa L.
bluegrass, Kentucky	P. pratensis L.
bluegrass, Sandberg	P. secunda Presl
brome, cheatgrass (See cheatgrass)	
brome, meadow	Bromus erectus Huds.
brome, mountain	B. carinatus Hook. & Arn.
brome, smooth	B. inermis Leyss.
canarygrass, reed	Phalaris arundinacea L.
cheatgrass	Bromus tectorum L.
chokecherry	Prunus virginiana L.
clover	Trifolium spp.
clover, alsike	T. hybridum L.
coneflower	Rudbeckia occidentalis Nutt.
Douglas-fir	Pseudotsuga menziesii (Mirb.) Franco
fescue, Chewings	Festuca rubra var. commutata Gaud.
fescue, Idaho	F. idahoensis Elmer
fescue, red	F. rubra L.
fescue, sulcata	F. ovina ssp. sulcata Hack.
fescue, tall	F. arundinacea Schreb.
fir	Abies spp.
foxtail, meadow	Alopecurus pratensis L.
halogeton	Halogeton glomeratus C. A. Mey.
horsebrush, spineless	Tetradymia canescens DC.
junegrass, prairie	Koeleria cristata (L.) Pers.
juniper	Juniperus spp.
knotweed	Polygonum spp.
maple, bigtooth	Acer grandidentatum Nutt.
medusahead	Elymus caput-medusae L.
mountain-mahogany, curlleaf	Cercocarpus ledifolius Nutt.
mustards	Sisymbrium spp. and Descurainia spp.
needle-and-thread	Stipa comata Trin. & Rupr.
needlegrass, Thurber	S. thurberiana Piper
oatgrass, tall	Arrhenatherum elatius (L.) Presl
orchardgrass	Dactylis glomerata L.
pine, lodgepole	Pinus contorta Dougl.
pine, singleleaf pinyon	P. monophylla Torr. & Frem.
pine, ponderosa	P. ponderosa Laws.
rabbitbrush	Chrysothamnus spp.
rabbitbrush, rubber	C. nauseosus (Pall.) Britton
redtop	Agrostis alba L.
ricegrass, Indian	Oryzopsis hymenoides (Roem. & Schult.) Ricker

Common name	Scientific name
Russian-thistle	Salsola kali var. tenuifolia Tausch
sagebrush, big	Artemisia tridentata Nutt.
sagebrush, low	A. arbuscula Nutt.
sagebrush, silver	A. cana Pursh
sagebrush, threetip	A. tripartita Rydb.
saltbush, shadscale (See shadscale)	
serviceberry	Amelanchier alnifolia Nutt.
shadscale	Atriplex confertifolia (Torr. & Frem.) Wats.
snowberry	Symphoricarpos spp.
snowbrush	Ceanothus velutinus Dougl. ex Hook.
spruce	Picea spp.
squirreltail	Sitanion hystrix (Nutt.) J. G. Smith
tarweed	Madia glomerata Hook.
timothy	Phleum pratense L.
trefoil, birdfoot	Lotus corniculatus L.
wheatgrass, beardless	Agropyron inerme (Scribn. & Smith) Rydb.
wheatgrass, bluebunch	A. spicatum (Pursh) Scribn. & Smith ex Link
wheatgrass, crested	A. desertorum (Fisch.) Schult.
wheatgrass, fairway	A. cristatum (L.) Gaertn.
wheatgrass, intermediate	A. intermedium (Host) Beauv.
wheatgrass, pubescent	A. trichophorum (Link) Richt.
wheatgrass, Siberian	A. sibiricum (Willd.) Beauv.
wheatgrass, slender	A. trachycaulum (Link) Malte
wheatgrass, streambank	A. riparium Scribn. & Smith
wheatgrass, tall	A. elongatum (Host) Beauv.
wildrye, Great Basin	Elymus cinereus Scribn. & Merr.
wildrye, medusahead (See medusahead)	
wildrye, Russian	E. junceus Fisch.
winterfat ("white sage")	Eurotia lanata (Pursh) Moq.
wyethia	Wyethia spp.

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APPENDIX

The following table lists 237 range forage species tested in experimental plots for usefulness in seeding rangelands in southern Idaho. Plantings were made at one or more locations each year during the period 1936 to 1955--by personnel of the Intermountain Forest and Range Experiment Station prior to 1954, and by the Agricultural Research Service subsequently.

Symbols in the table show a comparative rating of adaptability of these species for use on six classes of sites commonly found in this area. Ratings should be regarded as indicative rather than precise because of the variety of growing conditions within sites, the varied lengths of testing periods, and the different methods of seeding used throughout the 2 decades of the testing.

We have rated adaptation of individual species to environmental conditions on a scale of 1 to 3 as follows:

1 Adapted to the site and generally useful for range seeding in southern Idaho.

2 Either (a) adapted to the site and useful for special conditions, (b) adapted, but of little value for seeding southern Idaho rangelands, or (c) promising, but not yet adequately tested.

3 Failed to survive where tested, and presumed not to be adapted.

\- Not tested for this site.

* Recommended in this publication for range seeding. (Some species carry this symbol in addition to either 1 or 2.)

Adaptability of grass species tested on varied types of sites in southern Idaho, 1936-1955

Species	Harsh sagebrush	Intermediate sagebrush	Favorable sagebrush	Mtn. brush & pond. pine	Mountain meadows	High altitude
Achillea lanulosa Nutt.	-	3	2	2	-	-
Aeluropus littoralis (Gouan) Parl.	-	3	-	-	-	-
Agastache urticifolia (Benth.) Kuntze	-	3	3	2	-	-
Agoseris glauca var. laciniata (D. C. Eat.) Smiley	-	3	3	3	-	-
Agropyron ciliare (Trin.) Franch.	-	3	3	3	-	-
A. cristatum (L.) Gaertn. (several strains)	1*	1*	1*	1*	3	2
A. dasystachyum (Hook.) Scribn.	3	2	2	2	3	-
A. desertorum (Fisch. ex Link) Schult.	1*	1*	2*	1*	3	3
A. elongatum (Host) Beauv.	3	2*	1*	2*	3	3
A. inerme (Scribn. & Smith) Rydb. (several strains)	2	1*	2*	1*	3	3
A. intermedium (Host) Beauv.	2	1*	1*	1*	1*	1*
A. popovii Drob.	-	3	-	2	-	-
A. repens (L.) Beauv.	-	3	-	2	2	-
A. riparium Scribn. & Smith	2	2	2	2	-	-
A. semicostatum (Steud.) Nees ex Boiss	3	3	3	3	-	-
A. sibiricum (Willd.) Beauv.	2*	2*	2*	2*	-	-
A. smithii Rydb.	3	2	2	2	2	3
A. spicatum (Pursh) Scribn. & Smith (several strains)	2	1*	2*	1*	3	3
A. subsecundum (Link) Hitchc.	3	3	3	2	2	2
A. trachycaulum (Link) Malte	3	3	3	2*	2	1*
A. trichophorum (Link) Richt.	2	1*	1*	1*	2	2*
Agrostis alba L.	-	3	3	3	2	2
Alopecurus pratensis L.	-	-	2	-	1*	2*
Amelanchier alnifolia Nutt.	-	-	-	2	-	-
Ammophila arenaria (L.) Link	3	3	3	-	-	-
Andropogon gerardi Vitman	-	3	-	3	-	-
A. ischaemum L.	-	3	-	-	-	-
A. scoparius Michx.	-	3	-	-	-	-
Aristida fendleriana Steud.	-	-	-	3	-	-
A. longiseta Steud.	-	3	-	3	-	-
Arrhenatherum elatius (L.) Presl (two strains)	3	3	3	1*	2	2*
Artemisia abrotanum L.	3	2	2	2	-	-
A. arbuscula Nutt.	-	-	-	2	-	-
A. bigelovii Gray	3	3	-	-	-	-
A. dracunculus L.	-	-	-	2	-	-
A. frigida Willd.	3	3	-	3	-	-
A. nova A. Nels.	2	2	-	3	-	-
A. tridentata Nutt.	2	2	-	2	-	-
A. tripartita Rydb.	2	2	-	-	-	-
A. spinescens D. C. Eat.	3	3	-	3	-	-
Aster adscendens Lindl.	3	3	-	3	-	-
Astragalus chinensis L.	3	3	-	3	-	-
A. cicer L.	-	-	2	-	3	3
A. diversifolius Gray	3	2	-	3	-	-
A. falcatus Lam.	3	2	2	2	3	2
A. mortoni Nutt.	3	3	-	3	-	-
A. rubyi Green & Morris	3	3	-	3	-	-
A. stenophyllus T. & G.	3	3	2	3	-	-
Atriplex canescens (Pursh) Nutt.	2	2	-	3	-	-
A. confertifolia (Torr. & Frem.) Wats.	-	3	-	3	-	-
A. gardneri (Moq.) Stendl.	3	3	-	-	-	-
Balsamorhiza sagittata (Pursh) Nutt.	3	2	2	2	-	-
Bassia hyssopifolia (Pall.) Kuntze	2	3	-	3	-	-
Blepharidachne kingii (S. Wats.) Hack.	-	3	-	3	-	-
Bouteloua curtipendula (Michx.) Torr.	-	3	-	3	-	-
B. eriopoda (Torr.) Torr.	-	3	-	3	-	-
B. gracilis (H.B.K.) Lag. ex Steud.	3	2	-	3	-	-
B. hirsuta Lag.	-	3	-	-	-	-

Species	Harsh sagebrush	Intermediate sagebrush	Favorable sagebrush	Mtn. brush & pond. pine	Mountain meadows	High altitude
Bromus anomalus Rupr. ex Fourn.	-	3	-	3	-	-
B. carinatus Hook. & Arn. (several strains)	3	3	2	2	2	1*
B. erectus Huds.	-	2	2*	2*	2*	2
B. inermis Leyss. (several strains)	3	2	1*	1*	1*	1*
B. mollis L.	-	-	-	3	-	-
B. tomentellus Boiss.	-	-	-	2	-	2
Calamagrostis epigeios (L.) Roth	3	2	-	2	-	-
C. montanensis Scribn.	-	2	-	3	-	-
Calamovilfa gigantea (Nutt.) Scribn. & Merr.	-	3	-	-	-	-
C. longifolia (Hook.) Scribn.	3	3	-	3	-	-
Caragana arborescens Lam.	3	3	2	2	-	-
Ceanothus velutinus Dougl. ex Hook.	-	3	-	2	-	-
Cercis occidentalis Torr. ex Gray	-	3	-	3	-	-
Cercocarpus ledifolius Nutt.	-	3	-	2	-	-
C. montanus Raf.	-	3	-	3	-	-
Chrysothamnus lanceolatus Nutt.	-	-	-	3	-	-
C. nauseosus (Pall.) Britton	-	-	-	2	-	-
C. viscidiflorus (Hook.) Nutt.	-	-	-	3	-	-
C. viscidiflorus var. stenophyllus (Nutt.) Hall & Clem.	-	-	-	3	-	-
Clematis ligusticifolia Nutt. ex T. & G.	-	-	-	2	-	-
Cornus stolonifera Michx.	-	-	-	2	-	-
Cowania stansburiana Torr.	3	3	-	-	-	-
Crepis acuminata Nutt.	3	2	2	2	-	-
Cytisus scoparius (L.) Link	-	-	-	3	-	-
Dactylis glomerata L.	-	3	3	1*	2	1*
Distichlis stricta (Torr.) Rydb.	-	3	-	3	-	-
Drymocallis sp.	-	3	-	3	-	-
Elaeagnus angustifolia L.	3	3	-	2	-	-
Elymus canadensis L.	3	3	3	3	3	-
E. chinensis (Trin.) Keng	-	3	-	-	-	-
E. cinereus Scribn. & Merr.	3	3	2	2	-	2
E. dahuricus Griseb.	-	3	-	3	-	-
E. flavescens Scribn. & Smith	-	2	3	3	-	-
E. glaucus Buckl.	3	3	3	2	3	2
E. junceus Fisch.	2*	1*	2*	2*	3	2
E. pseudoagropyrum Trin. ex Turcz.	-	2	-	-	-	-
E. salina Jones	3	2	2	2	3	-
E. sibiricus L.	3	3	-	3	-	-
E. triticoides Buckl.	3	3	2	2	3	-
E. virginicus L.	-	3	-	3	-	-
Ephreda nevadensis Wats.	-	-	-	3	-	-
Eragrostis curvula (Schrad.) Nees	-	3	-	3	-	-
E. lehmanniana Nees	-	-	-	3	-	-
Erigeron ursinus D. C. Eat.	-	3	-	3	-	-
Eriogonum heracleoides Nutt.	-	2	2	2	-	-
E. umbellatum Torr.	-	3	-	2	-	-
Erodium cicutarium (L.) L'Her.	-	3	-	3	-	-
Eurotia lanata (Pursh) Moq.	2	2	-	3	-	-
Festuca arizonica Vasey	3	3	-	3	-	-
F. arundinacea Schreb.	-	-	-	3	2	3
F. elatior L.	-	3	3	3	2	3
F. idahoensis Elmer	3	2	2	2	3	-
F. ovina L.	3	3	2	2	2	-
F. ovina var. brachyphylla (Schult.) Piper	-	3	-	2	2	-
F. ovina var. duriuscula (L.) Koch	3	3	3	3	3	2
F. ovina ssp. sulcata Hack.	3	3	2	2	2	2
F. rubra L.	-	3	2	2	2	2

Adaptability of grass species tested on varied types of sites in southern Idaho, 1936-1955 (con.)

Species	Harsh sagebrush	Intermediate sagebrush	Favorable sagebrush	Mtn. brush & pond. pine	Mountain meadows	High altitude
F. rubra var. commutata Gaud.	-	-	-	2*	2*	1*
Geranium viscosissimum F. & M.	-	3	-	3	-	2
Gleditsia triacanthos L.	-	3	-	3	-	-
Glycyrrhiza lepidota Pursh	3	3	-	3	-	-
Grayia spinosa (Hook.) Moq.	-	3	-	3	-	-
Gutierrezia sarothrae (Pursh) Britt. & Rusby	-	-	-	3	-	-
Hedysarum boreale Nutt.	3	3	2	2	-	-
Helianthella uniflora (Nutt.) T. & G.	3	3	2	3	-	-
Heracleum lanatum Michx.	-	3	-	3	-	2
Hesperochloa kingii (S. Wats.) Rydb.	3	3	-	2	-	-
Heteropogon contortus (L.) Beauv.	-	-	-	3	-	-
Hilaria jamesii (Torr.) Benth.	-	3	-	3	-	-
H. mutica (Buckl.) Benth.	-	3	-	3	-	-
H. rigida (Thurb.) Benth. ex Scribn.	-	3	-	3	-	-
Holcus lanatus L.	-	3	-	3	-	-
Hordeum bulbosum L.	3	3	2	2	2	3
Juniperus osteosperma (Torr.) Little	-	-	-	3	-	-
J. scopulorum Sarg.	-	-	-	2	-	-
Kochia scoparia (L.) Schrad.	2	2	-	-	-	-
Koeleria cristata (L.) Pers.	3	3	-	2	-	-
Lespedeza stipulacea Maxim.	-	3	-	3	-	-
Ligusticum porteri C. & R.	-	3	-	3	-	-
Lolium multiflorum Lam.	-	3	-	3	-	-
L. perenne L.	-	3	3	3	-	-
L. remotum Schrank	-	-	-	3	-	-
Lomatium dissectum var. multifidum (Nutt.) Mathias & Const.	-	3	-	3	-	-
L. simplex (Nutt.) Macbr.	-	3	-	-	-	-
Lotus corniculatus L.	-	3	-	3	2	2
Lupinus alpestris A. Nels	-	3	-	3	2	2
L. caudatus Kell.	3	2	2	2	-	-
L. leucophyllus Dougl. ex Lindl.	3	2	2	2	-	-
L. sericeus Pursh	3	3	2	2	-	-
Lycium halimifolium Mill.	-	-	-	3	-	-
Medicago lupulina L.	-	-	-	3	-	-
M. sativa L. (several varieties)	3	2*	2*	2*	2	3
M. tribuloides Desr.	-	3	-	-	-	-
Melica bulbosa Geyer ex Port. & Coult.	-	3	-	3	-	-
Melilotus alba Desr. (two varieties)	3	3	-	3	3	3
M. officinalis (L.) Lam.	3	3	3	3	3	3
Muhlenbergia porteri Scribn.	-	3	-	3	-	-
Onobrychis viciaefolia Scop.	-	2	-	2	-	-
Oryzopsis bloomeri (Boland.) Ricker	-	3	-	-	-	-
O. hymenoides (Roem. & Schult.) Ricker	2	2	2	2	-	-
O. miliacea (L.) Benth. & Hook. ex Aschers. & Schweinf.	3	3	-	3	-	-
Penstemon cyananthus Hook.	3	3	-	-	-	-
P. palmeri Gray	3	3	-	2	-	-
P. rydbergii A. Nels.	-	3	-	3	-	-
P. speciosus Dougl. ex Lindl.	3	3	-	-	-	-
Pentzia incana (Thunb.) Kuntze	-	3	-	3	-	-
Phalaris arundinacea L.	-	3	3	3	2	2
P. tuberosa var. stenoptera (Hack.) Hitchc.	3	3	-	3	-	-
Phleum pratense L.	-	3	3	2*	1*	1*
Physocarpus malvaceus (Greene) Kuntze	-	-	-	3	-	-
Pinus edulis Engelm.	3	-	-	-	-	-
Poa ampla Merr.	3	2*	2*	2*	2	3
P. bulbosa L.	2	2*	2*	2*	3	3
P. canbyi (Scribn.) Piper	-	2	-	2	-	-
P. compressa L.	3	3	-	2	-	-
P. cusickii Vasey	3	2	-	3	-	-
P. fendleriana (Steud.) Vasey	3	3	-	2	-	-
P. juncifolia Scribn.	3	2	2	2	-	-
P. longiligula Scribn. & Williams	3	3	-	2	-	-
P. macrantha Vasey	3	3	-	3	-	-
P. nevadensis Vasey ex Scribn.	3	2	2	2	2	-
P. pratensis L.	-	3	-	2	2	-
P. secunda Presl	2	2	2	2	-	-
P. sterilis Bieb.	-	-	-	3	-	-
Polygonum phytolaccaefolium Meissn.	-	3	-	3	-	-
Prunus emarginata (Dougl.) Walp.	-	-	-	2	-	-
P. virginiana var. melanocarpa (A. Nels.) Sarg.	-	3	-	2	-	-
Psoralea stenostachys Rydb.	-	3	-	3	-	-
Puccinellia airoides (Nutt.) Wats. & Coult.	-	3	-	-	-	-
Purshia tridentata (Pursh) DC.	3	2	2	2	-	-
Quercus gambelii Nutt.	-	3	-	3	-	-
Rhus trilobata Nutt. ex T. & G.	-	3	-	3	-	-
Ribes aureum Pursh	-	3	-	3	-	-
Sambucus caerulea Raf.	-	3	-	2	-	-
S. melanocarpa Gray	-	3	-	2	-	-
S. microbotrys Rydb.	-	3	-	3	-	-
Sanguisorba minor Scop.	3	3	-	2	-	-
Secale cereale L.	3	3	3	3	3	-
S. montanum Guss.	3	2	3	3	-	3
Senecio serra Hook.	-	3	3	3	-	-
Shepherdia argentea Nutt.	-	-	-	3	-	-
Sitanion hystrix (Nutt.) J. G. Smith	2	2	2	2	-	-
Sorghastrum nutans (L.) Nash	-	3	-	-	-	-
Sorghum sudanense (Piper) Stapf	3	3	3	3	-	-
Sphaeralcea grossulariaefolia (H. & A.) Rydb.	-	3	-	3	-	-
S. munroana (Dougl.) Spach.	-	3	-	-	-	-
Sporobolus airoides (Torr.) Torr.	-	3	-	3	-	-
S. asper (Michx.) Kunth	-	-	-	3	-	-
S. cryptandrus (Torr.) A. Gray	3	3	-	3	-	-
Stipa arida Jones	3	3	-	3	-	-
S. columbiana Macoun	3	3	2	2	-	2
S. columbiana var. nelsoni (Scribn.) Hitchc.	3	3	-	2	-	-
S. comata Trin. & Rupr.	3	2	2	2	-	-
S. coronata var. depauperata (Jones) Hitchc.	-	3	-	-	-	-
S. lettermani Vasey	3	3	-	2	-	2
S. occidentalis Thurb.	-	2	-	2	-	-
S. pulchra Hitchc.	3	3	-	3	-	-
S. robusta (Vasey) Scribn.	3	3	-	3	-	-
S. speciosa Trin. & Rupr.	-	3	-	-	-	-
S. thurberiana Piper	3	2	-	-	-	-
S. viridula Trin.	3	2	2	-	-	-
Symphoricarpos oreophilus A. Gray	-	3	-	3	-	-
Thermopsis montana Nutt. ex T. & G.	-	3	-	3	-	-
Tragopogon porrifolius L.	-	3	-	3	-	-
Trifolium fragiferum L.	-	3	-	3	3	-
T. hybridum L.	-	-	-	3	2	2
T. lappaceum L.	-	3	-	-	-	-
T. lupinaster L.	-	3	-	-	-	-
T. macrocephalum (Pursh) Poir.	-	3	-	3	-	-
T. repens L. (two varieties)	-	3	3	3	3	-
T. subterraneum L.	-	3	-	-	-	-
T. wormskioldii Lehm	-	3	-	3	-	-
Tridens pilosus (Buckl.) Hitchc.	-	3	-	-	-	-
Vicia americana Muhl.	-	3	-	-	-	-
V. tenuifolia Roth	-	2	3	-	-	-
V. villosa Roth	3	3	-	3	-	2
Viguiera multiflora (Nutt.) Blake	3	3	3	2	-	-
Wyethia amplexicaulis Nutt.	3	3	-	2	-	-
Zoysia japonica Steud.	-	3	-	-	-	-

FOREST SERVICE CREED

The Forest Service of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives--as directed by Congress--to provide increasingly greater service to a growing Nation.

Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Project headquarters are also at:

Boise, Idaho
Bozeman, Montana (in cooperation with Montana State College)
Logan, Utah (in cooperation with Utah State University)
Missoula, Montana (in cooperation with Montana State University)
Moscow, Idaho (in cooperation with the University of Idaho)
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